National Aeronautics and Space Administration

NASAfacts

Aviation Systems Division

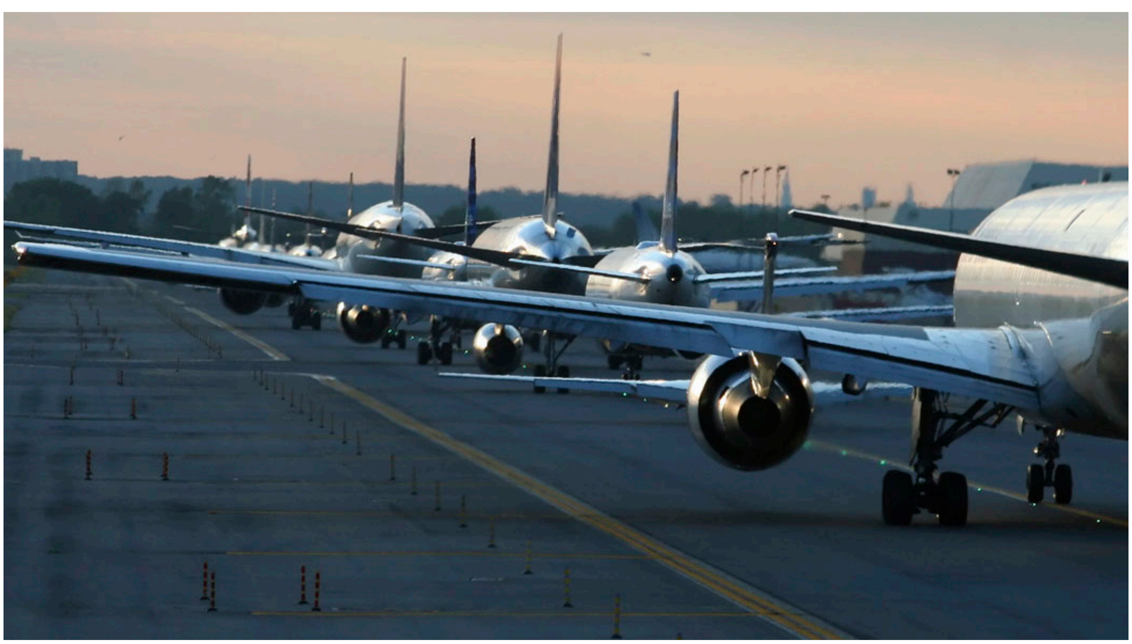
The Aviation Systems Division of NASA Ames Research Center conducts research and development in two primary areas: air traffic management and high-fidelity flight simulation.

Air traffic management researchers are creating and testing concepts that enable up to three times today's level of air traffic in the national airspace. Automation and addressing any potential safety impact are key foundations of the concept development. Historically, the Division has developed products that have subsequently been implemented for the flying public, such as the Traffic Management Advisor (TMA), which has been deployed nationwide.

In high-fidelity flight simulation, the Division operates the world's largest flight simulator (the Vertical Motion Simulator), a Level-D 747-400 flight simulator, an advanced cockpit flight simulator, and a panoramic air traffic control tower simulator. These simulators have been used for a variety of purposes including continued training for Space Shuttle pilots, development of future spacecraft handling qualities, helicopter control system testing, Joint Strike Fighter evaluations, and accident investigations. Division personnel have a variety of technical backgrounds, including guidance and control, flight mechanics, flight simulation, and computer science. Customers outside of NASA have included the Federal Aviation Administration (FAA), and the Departments of Defense, Homeland Security, Transportation, and the National Transportation Safety Board (NTSB).

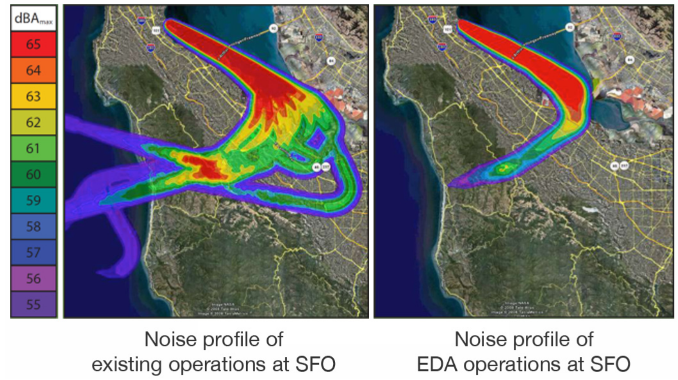
AIRPORT SURFACE AUTOMATION

The surface of the airport is a major bottleneck and limitation to future air transportation growth. Congestion cannot simply be relieved by adding runways as airport surface operations are often constrained by the airport's location. Projected increases in traffic levels pose challenges for pilot and controller workload, increase the complexity of planning, managing, and executing safe and efficient surface operations, and also increase environmental impact.



The Aviation Systems Division at NASA Ames Research Center conducts research in air traffic management to improve the safety, capacity, and efficiency of the National Airspace System, and to reduce its environmental impact.

Researchers run a simulation of the Terminal Area Procedures for Paired Runways (TAPPR) concept in NASA's Air Traffic Management Laboratory.



San Francisco International Airport flight test data shows significant noise reduction resulting from idle-thrust descents enabled by the Efficient Descent Advisor (EDA).

Aviation Systems Division researchers are now investigating today's surface operations to determine the constraints and sources of uncertainties, to develop ways to minimize those uncertainties, and to create controllability options to eventually develop trajectory-based optimized taxi planning and runway scheduling strategies and algorithms. Researchers are evaluating how to reduce the frequency of runway incursions and identifying procedures and requirements that will aid in assessing and reducing the environmental impact of increased surface traffic. The Division is also contributing to understanding how these new surface capabilities will affect the human operator.

All of these ongoing research efforts will eventually lead to a new concept of operations for surface traffic management and control, which will need to operate seamlessly with terminal area airspace operations, in the airspace immediately surrounding the airport surface. The Aviation Systems Division is actively researching the integration of future surface and terminal area operational concepts.

TACTICAL AIR TRAFFIC MANAGEMENT

Tactical air traffic management (tactical ATM) develops solutions for an approximately 20-minute planning horizon. As future traffic levels are projected to increase dramatically in some airspaces, such as the super-density terminal areas around major airports and high-density en route airspaces, more accurate prediction and precise control of aircraft separation is needed. The primary limitation to increased high-density en route operations has been shown to be controller workload associated with maintaining safe aircraft separation. Evaluating safe reductions in the aircraft separation standards and mitigating the environmental impact of increased air traffic are also important areas of investigation.

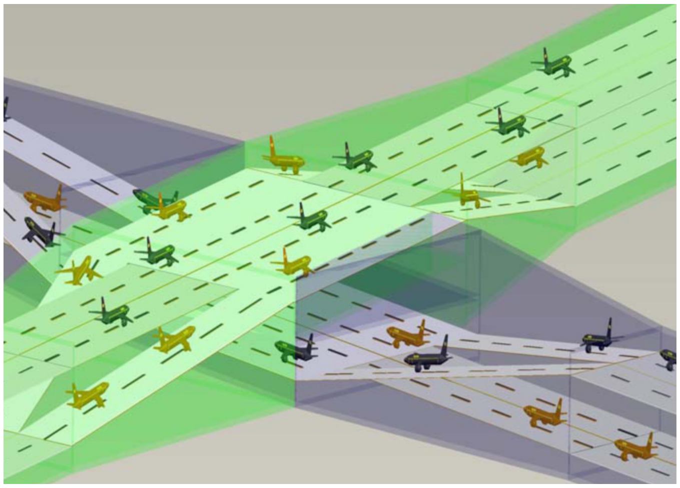
The Division conducts cutting edge research in the use of tactical ATM automation in aircraft and in ground-based operations, and is investigating 4D trajectory prediction, conflict detection in the presence of uncertainty, and robust automated resolution logic. Researchers are also identifying novel methods for using automation to enable maintaining safe separation in the presence of a potential three times growth in traffic levels.

Innovative applications of tactical ATM in super-density terminal operations include: (1) increasing capacity at airports with closely spaced parallel approaches; (2) maximizing the arrival rate of individual runways by assuring that the spacing between aircraft on final approach are safely minimized; and (3) efficiently integrating arrivals and departures within a Metroplex (an airspace environment comprising multiple large, interdependent airports) to fully utilize all available runways. Researchers are also investigating the controller's ability to adhere to and manage reduced separation standards; this work is being closely coordinated with related research in wake vortex detection and the simultaneous use of the same runway for arrivals and departures.

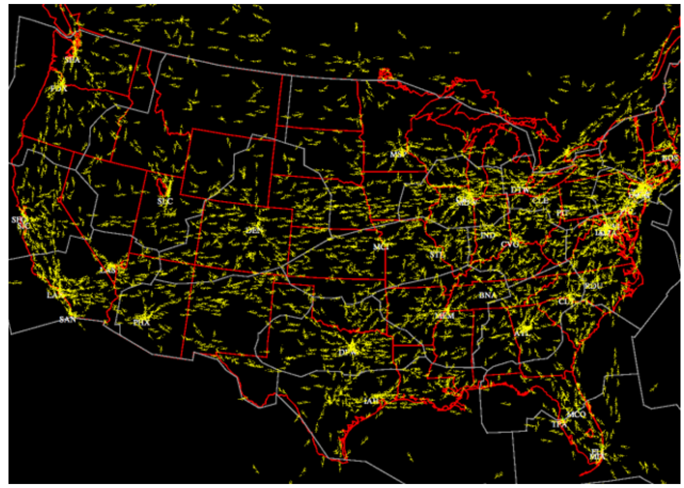
Environmentally friendly arrivals are also being tested, to identify new technologies and procedures that will enable aircraft to "coast" from cruise to touchdown thereby reducing fuel, emissions and noise. Currently, the primary limitation of these techniques is developing procedures to fly such descents in heavy traffic. As new technologies are developed to aid in the routine operational use of such descents, there will be a greater choice in the levels of traffic under which specialized descents may be accommodated.

STRATEGIC AIR TRAFFIC MANAGEMENT

Air traffic management also has a strategic component



Dynamic Airspace Configuration (DAC) research explores the possibility of grouping aircraft with similar flight paths, creating "highways-in-the-sky," in order to increase airspace capacity.



The Future Air Traffic Management Concepts Evaluation Tool (FACET) is used to model the flow of air traffic across the U.S. A snapshot of all the flights over the U.S. at a given time is depicted.

(strategic ATM) that addresses Traffic Flow Management (TFM) at regional and national levels. The challenges in this domain are to develop nation-wide TFM solutions that address imbalances in the forecasted air traffic demand and airspace capacity, while accommodating airline preferences and maximizing airspace system throughput and efficiency.

Strategic ATM comprises airspace operations, guidance and control, human factors, and software engineering. The Division conducts strategic ATM foundational research in the development of algorithms, models, and concepts. The Division's TFM research is investigating how to achieve optimal traffic flow control by improving the prediction accuracy of the available National Airspace System resources and air traffic demand. To meet the TFM challenges of the future air transportation system while improving current day operations, the Division is pursuing a diverse research portfolio that is: (1) developing linear, non-linear, heuristic, and decomposition methods for designing flow management strategies; (2) translating weather data into air traffic management impacts; and (3) developing techniques for incorporating airline preferences into traffic flow management.

Another element of strategic ATM, called Dynamic Airspace Configuration (DAC), accomplishes a task similar to TFM, although on a longer time horizon, by redefining and modifying the structure of the airspace itself. To evaluate the potential of new airspace structures, the Division is conducting research to: (1) create new classes of airspace that take advantage of new technologies such as self-separation and 4D-trajectories; (2) dynamically change the airspace to meet the forecasted demand; and (3) define the characteristics of a generic region of airspace that will enable interchangeability between facilities and controllers.

MODELING AND SIMULATION

Before deciding on what concepts to recommend for implementation in the National Airspace System, they are first modeled and simulated in software. This approach helps to guide the research and establish a cost-benefits case for a new concept.

The Division has a host of modeling and simulation tools to accomplish such testing. The Airspace Concept Evaluation System (ACES) has been used to evaluate the benefits of new ideas at a system level as well as examine and refine individual concepts such as the Advanced Airspace Concept. The Future Air traffic management Concepts Evaluation Tool (FACET) has been used extensively to model the flow of air traffic across the U.S., and is used to evaluate new concepts in airspace design, traffic flow management, and optimization. Lastly, the overall air traffic control environment can be simulated in real-time in the Division's air traffic management automation laboratory, which is a unique capability that receives live radar data feeds of the nation's air traffic to enable our concepts to be tested under real-world conditions.

FACILITIES AND CAPABILITIES

The Aviation Systems Division houses some of the most sophisticated simulation facilities in the world. We support a wide range of research, with emphasis on aerospace vehicles, aerospace systems and operations, human factors, accident investigations, and studies aimed at improving aviation safety.

FutureFlight Central (FFC) is a national simulation facility that offers a 360-degree, full-scale, real-time simulation of an airport, where controllers, pilots and airport personnel participate to optimize expansion plans, operating procedures, and evaluate new technologies.

An experienced air traffic controller controls traffic at a simulated airport in the FutureFlight Central air traffic control tower simulator.

Using CVSRF's highly sophisticated simulators and ATC Laboratory, researchers are able to study the effects of aviation automation and advanced instrumentation on human performance.

The ***Vertical Motion Simulator (VMS)*** enables scientists to conduct advanced research in a unique flight simulation complex. The facility provides researchers with exceptional tools to explore, define, and solve issues in both aircraft and spacecraft design. It offers fast and cost-effective solutions using real-time piloted simulation, realistic sensory cues, and the greatest motion range of any flight simulator in the world. Flexibility in both hardware and software allows any type of vehicle to be simulated and evaluated, whether existing or conceptual. Existing vehicles simulated include airships, helicopters, fighter jets, and the Space Shuttle Orbiter. Conceptual vehicles simulated include Tilt-Rotor, Tilt-Wing, High-Speed Civil Transports, and Advanced Vertical Short Take-off and Landing (VSTOL) aircraft. The VMS is also an important resource for simulating the next-generation space transportation vehicles.

The ***Crew-Vehicle Systems Research Facility (CVSRF)*** houses two high-fidelity flight simulators and an air traffic control simulation laboratory capable of full-mission simulation that can interact with each other, allowing for enormous flexibility and customization, thus enabling researchers to study the effects of automation on human performance.

Through ***Virtual Airspace Simulation Technologies (VAST)***, CVSRF is integrated with FFC and the VMS to provide simultaneous cockpit and air traffic control perspectives. This unique capability enables simultaneous testing of new airspace concepts across multiple domains and creates the building blocks for more comprehensive simulations of the National Airspace System.

The ***NASA/FAA North Texas Research Station (NTX)*** is a collaborative effort between NASA Ames Research Center and the FAA to support ATM research through field evaluations, shadow testing, simulation evaluations, and data collection and analysis. NTX is located on the premises of the FAA's Ft. Worth Air Route Traffic Control Center, in close proximity to Dallas/Ft. Worth International Airport and several major airline facilities. This unique location, combined with an experienced engineering staff, high-quality infrastructure and long-standing relationships with key FAA, air carrier and airport organizations, enables NTX to support the full range of ATM research activities.

Two air traffic control simulation laboratories are also available to simulate advanced ATM concepts with human operators in the loop. In addition to engineering data on algorithm and concept performance, data can be collected on human reaction time, user preferences, interface design, procedures, and communications.

The Division also maintains research laboratories where live radar and weather data from US air traffic facilities is used to test and evaluate the capabilities and functionality of the ATM software developed by Division researchers.

For more information about the NASA Aviation Systems Division, **visit www.aviationsystems.arc.nasa.gov**.

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